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Physico-Chemical Characterization Of Water Samples At Egbin Thermal Station In Ijede And Its Environs In Lagos State Of Nigeria.

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Abstract

With the view to determining the effect of industrial effluents on the water quality of the river at Ijede in Ikorodu, Lagos state of Nigeria as a result of the panicking situation within the community, the physicochemical parameters which include PH, Turbidity, Dissolved Oxygen, Salinity and Electrical conductivity were measured to ascertain the level of pollution in the river and the Environment. The result shows that the pollutions of this river, if any, were not really from the effluent coming out of the Plant, but attributed to other sources since the effluents from the Plant were well managed and the physico-chemical parameters are in good agreement with World Health Organization guidelines before it is discharged into the main river. It is therefore recommended that the control on the effluents management should be controlled and enforced by the Environmentalists to protect the activities of the residents at Egbin in Ijede and its environs.

Key words: Physico-chemical, Pollution, Discharged-water, WHO.

Introduction

The use of water to generate Power at Hydropower facilities imposes insignificant ecological impacts since diversion of water out of the river removes water for healthy in-stream ecosystems (Ahmed and Haque, 2010). Stretches below dams are often completely de-watered as well as fluctuations of flow from peaking operations create a "tidal effect", disrupting the downstream riparian community that supports its unique ecosystem (Borah, *et. al,* 2009). A dam's impoundment slows water flows, which hinders natural downstream migration of many fish species. By slowing river flow, dams also allow silt to collect on river and reservoir bottoms and bury fish spawning habitat. According to Boxall et al (2000) silt trapped above dams accumulates heavy metals and other pollutants. Disrupting the natural flow of sediments in rivers also leads to erosion of riverbeds downstream of the dam and increases risks of floods.

The impoundment of water by Hydropower facilities fundamentally reshapes the physical habitat from a riverine to an artificial pond community (Fakayode 2005, Dan'azumi and Bichi 2010). This often eliminates native population of fish and other wildlife. Dams also impede the upstream and downstream movements of fish and other wildlife, and prevent the flow of plants and nutrients (Agedengbe, et.al, 2003). This impact is most significant on migratory fish, which are born in the river and must migrate downstream early in life to the ocean and then migrate upstream again to lay their eggs (or "spawn"). As mentioned above, withdrawal of water into turbines can also impinge or entrain significant numbers of fish.

The requirements of different industries are so varied that water suitable for one industry may not be for another industry. Many parameters (physical and chemical) are determined and they are for different reasons. The values of the parameters obtained may cause for a rejection or acceptance of the sample and there are two types of limits that can cause for a rejection of the water. The first limit is the level at which the water sample will likely be objectionable to an appreciable number of people, desirable limit (WHO 2000 and Osibanjo et al 2011) while the second limit applies to the level, which must not be exceeded due to the recognized toxicants, tolerable limit (Dubey, 2013)

Water in general plays a crucial part in the maintenance of plant and animal life.

The main objective of the International Drinking Water Supply and Sanitation Decade (1981 – 1990) was to provide an adequate and safe supply of drinking water to the underserved population of the world. Nigeria is one of the undeserved nations of the world in terms of access to safe drinking water quality on health. The significance of water to human and other biological systems cannot be over emphasised, and there are numerous scientific and economic facts that, water shortage or its pollution can cause severe decrease in productivity and deaths of living species (Garba et al., 2008; Garba et al., 2010). Reports by Food and Agricultural Organisation (FAO) of U.S.A revealed that in African countries, particularly Nigeria, water related diseases had been interfering with basic human development (FAO, 2007). The common sources of water that are available to local communities in Nigeria are fast being severed by a number of anthropogenic factors, of which pollution remain the most dominant problem. Water pollution occurs when unwanted materials with potentials to threaten human and other natural systems find their ways into rivers, lakes, wells, streams, boreholes or even reserved fresh water in homes and industries. The pollutants are usually pathogens, silt and suspended solid particles such as soils, sewage materials, disposed foods, cosmetics, automobile emissions, construction debris and eroded banks from rivers and other waterways. Some of these pollutants are decomposed by the action of micro-organisms through oxidation and other processes. The major problem is the reconcentrations of these harmful substances in natural food chain (Osuide, 1990). During the decomposition process, natural bacteria and protozoan in the water source utilise the oxygen dissolved in the water. This could significantly reduce the oxygen level to less than two parts per million (<2ppm), therefore the respiratory conditions of aquatic species would be seriously affected. Consequently, fishes, bottom-dwelling animals and even marine plants can be contaminated and/or killed, creating significant disruption in the food chain. On the other hand, when this contaminated water is directly consumed without proper treatment (a common practice to local communities), spread of diseases such as typhoid, dysentery, cholera, hepatitis etc. will occur (Umeh, *et. al* 2004).

Analytical tests on water are grouped into physical, chemical and bacteriological tests. Lately, radiological test is becoming necessary especially in industrial set-up. Physical Analysis of water involves the measurement of the parameters of which the aims of this study are to examine the following from the Effluent Discharge namely: Appearance, Odour, Taste, pH, Conductivity, Salinity and Turbidity. Its purpose is the usual routine analysis on the state of pollution of the river water for the attention of Environmentalists and related Agencies for control to safe both aquatic bodies and human beings. It is also to educate and inform the settlers at Ijede via Ikorodu in Lagos on the state of the river water on which most of their pre-occupation lies.

Materials and Methods

The Experimental method involved two steps namely:

- Sample collection at various points. Altogether six water samples were collected
- Laboratory analysis of collected samples

I. Sample collection

The industrial waste water samples were collected with 1 litre sterile polyvinyl chloride (PVC) bottles that were previously cleaned by washing with non-ionic detergent, rinsed with tap water and later soaked in 10% HNO_3 for 24 hours and finally rinsed with deionised water prior to use. During sampling, sample bottles were rinsed with sampled water three times and then filled to the brim at a depth of one meter below the water from each of the six designated sampling points. The samples were labelled and taken to the laboratory, stored in the refrigerator at about 4ºC prior to analysis.

II. PHYSICO- CHEMICAL ANALYSIS

Physico-Chemical characteristics including pH, electrical conductivity, dissolved oxygen(DO), turbidity and salinity were analysed using different standard methods.

a. pH

pH is usually defined as the intensity of the acidic or basic character of a solution at agiven temperature. It is the negative logarithm of hydrogen ion concentration as stated

$$pH = - \log[H+].$$

pH values from 0 to 7 are diminishingly acidic, whereas values of 7 to 14 are increasingly alkaline. The pH of natural water usually lies in the range of 4.4 to 8.5.

The basic principle of electrometric pH measurement is of the activity of hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode. Glass electrode is also used instead of hydrogen electrode. The electromotive force (emf) produced in the glass electrode system varies linearly with pH. The instrument used for the measurement of pH (Model: Combo) was manufactured by Hanna Instruments (P) Ltd. The procedure of Ramteke and Moghe (1988) was adopted for the measurements.

For the calibration of pH meter, buffer solutions used were:

• Potassium hydrogen phthalate buffer:

A 10.2 g of potassium hydrogen phthalate was dissolved in water to prepare 1000ml of buffer. The pH of the buffer at 20^0C was 4.

• Phosphate buffer:

3.4 g of potassium dihydrogen phosphate and 4.45 g $Na_3HPO_4.2H_2O$ were dissolved in water to prepare 1000ml of buffer. The pH of the buffer at 20^0C was 6.9.

• Borax buffer:

Similarly 3.81 g of $Na_2B_4O_7.10H_2O$ was dissolved in water to prepare 1000ml of buffer. The pH value of the buffer at 20^0C was 9.22.

The pH meter was calibrated with buffer solutions and the instrument was immersed in a well-mixed sample and the readings were noted (Ramteke and Moghe, 1988).

b. Conductivity

Conductivity is a numerical expression of the ability of an aqueous solution to carry electric current. This ability depends on the presence of ions, their total concentration, mobility, valence and relative concentrations and on the temperature of measurement.

The instrument (manufactured by Hanna Instruments (P) Ltd) was used for the conductivity measurements. It consists of the source for alternating current, a Wheatstone bridge, a null indicator and a conductivity cell. The conductivity cell measures the ratio of alternating current through the cell to the voltage across it. Each of the Electrical Conductivitiy (EC in µS/cm) of the water samples was obtained by immersing the electrodes in a well-mixed sample (Ramteke and Moghe,1988).

c. **Turbidity**

Suspension of particles in water interfering with the passage of light is called turbidity. It could be caused by wide variety of suspended matter, which ranges in size from colloidal to coarse dispersion depending upon the degree of turbulence and also ranges from pure inorganic substances to those that are highly organic in nature.

Turbidity measurement using turbidity tube (manufactured by Jal-Tara.) method is based on the visual interpretation of the turbidity of water. The visual appearance of black cross-mark at the bottom of the tube, through the open end was used for turbidity measurement. A well-mixed sample was poured into the cleaned turbidity tube that was placed above the white sheet placed on the floor. The open end of the tube was observed to visualize the black markings from the distance of 7.0 to10.0 cm. The level of water at which the black mark was seen was noted and recorded accordingly.

d. Salinity

Salinity is simply a measure of the amount of salts dissolved in water. It is expressed in parts per thousand (ppt) or $^0/_0$ which can be measured either by physical or chemical methods. Physical methods use conductivity, density, or refractivity. The physical methods are quicker and more convenient than the chemical methods.

The electrometric method used for conductivity was the same used for the salinity in this experiment.

e. Dissolved Oxygen

Dissolved oxygen (DO) in water affects the oxidation-reduction state of many of the chemical compounds such as nitrate and ammonia, sulphate and sulphite, and ferrous and ferric ions. It is extremely useful in self-purification of water bodies. The reduction in DO levels causes anaerobic condition in water and adversely affects the aquatic biota. Even though much of the DO in water comes from the atmosphere due to wind action but Algae and rooted aquatic plants also give out
oxygen into water through photosynthesis.

When manganous sulphate is added to the sample containing alkaline potassium iodide, manganous hydroxide is formed, which is oxidized by the dissolved oxygen in the sample to basic manganic oxide. The basic manganic oxide liberates iodine equivalent to that of dissolved oxygen originally present in the sample. The liberated iodine is titrated with standard solution of sodium thiosulphate using starch as the indicator.

$MnSO_4 + 2\ KOH \rightarrow Mn\ (OH)_2 + K_2SO_4$---(1)

$2Mn\ (OH)_2 + O_2$(Dissolved oxygen) $\rightarrow 2MnO(OH)_2$--------------------------------(2)

[Basic manganic oxide, brown colour ppt]

$MnO(OH)_2 + 2H_2SO_4 \rightarrow Mn\ (SO_4)_2 + 3H_2O$---(3)

[manganic sulphate]

$Mn\ (SO_4)_2 + 2KI \rightarrow MnSO_4 + K_2SO_4 + I_2$---(4)

$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2Na$--(5)

Determination of Dissolved Oxygen: The sample was collected in 125ml BOD bottle carefully without allowing air bubbles. Added to the bottle were 1ml of manganous sulphate and 1ml of alkali iodide – azide reagent. A brown precipitate of basic manganic oxide formed was allowed to settle. Added to the solution was 1ml of concentrated sulphuric acid and mixed well until the precipitate dissolved. About 25ml of the solution was taken and titrated against sodium thiosulphate until a straw yellow colour appeared. Few drops of starch indicator was added and titrated again until the blue colour disappeared (Manivasakam, 1997).
The Dissolve Oxygen was calculated using the equation (6)

$$\text{Dissolved oxygen, mg/L} = \frac{(\text{ml*N}) \text{ of sodium thiosulphate*8*1000}}{V_2[(V_1-V)/V_1]} \quad (6)$$

where,
V_1 = Volume of sample bottle, V_2 = Volume of contents titrated, V = Volume of $MnSO_4$ and KI added (2ml)

Results and Discussion

All the water samples were colourless and clear. It is also odourless which confirmed non-presence of particles from microbial growth, see Table 1. The water samples discharged by Egbin Power Plants were first observed to identify the kind of taste which could be said to be a bit "Sour". The cause of this could be attributed to both inorganic and organic tearing and wearing of turbine materials coupled with unsaturated hydrocarbon oil and grease (Adeleye and Adebiyi, 2003).
Five physico-chemical properties were measured as depicted in Table 2. In comparing the measured pH values and then averaging the values shows that the activities in Egbin Thermal station could well be tolerated and controlled to some extent. This is because mean pH value is still close to neutral position which is 7.0 thereby making the water not too acidic on discharge to the main body of river water which is in good agreement with the recommendations of World Health Organization (WHO, 1999). This is an indication that all aquatic bodies in the river may not likely be affected hence fishing and all other river activities can still be carried on without any harmful effect.
For electrical conductivity and salinity measurements when compared with salty content as guided by WHO, it was observed to be much less than the tolerable value of 400 μScm^{-1}. It could be stated that the river is still acceptable to normal standard value since all water contains some water soluble salt which includes essential nutrients for plant growth. When the level of water soluble salts exceeds a certain level, harmful effects on plant growth occur. This is otherwise in this study hence inhabitants should be assured of their vegetation.
From Table 2, it was observed that the value obtained for turbidity is increasing as the value of dissolved oxygen decreases. This serves to correlate with the normal standard behaviour of the sample thereby rendering the samples more preferable to be accepted as normal detected value.

Conclusion

From the findings above, it can be said that the measured physic-chemical parameters do not constitute any kind of pollution to the flowing water. In conclusion, the discharged water from the Plant meet the WHO standard limit. Therefore it should be encouraged to ensure that Egbin Power Station consistently meets with these regulations to guarantee the safety of the ecosystem.

Table 1: Physical Observations of the water Discharged

S/NO	SAMPLE CODE	APPEARANCE	ODOUR	TASTE
1	A	Clear	Odourless	Bit Sour
2	B	Clear	Odourless	Bit Sour
3	C	Clear	Odourless	Bit Sour
4	D	Clear	Odourless	Bit Sour
5	E	Clear	Odourless	Bit Sour
6	F	Clear	Odourless	Bit Sour

Table 2: Concentration of physico-chemical parameters in water samples

S/NO	SAMPLE CODE	PHYSICO-CHEMICAL PARAMETERS DETECTED				
		pH	EC (μScm^{-1})	TURBIDITY (FTU)	SALINITY ($^0/_{00}$)	DO (mg/l)
1	A	6.82	180.0	18.0	0.05	3.70
2	B	6.71	150.0	4.0	0.04	4.40
3	C	6.92	160.0	10.0	0.04	4.20
4	D	6.86	150.0	12.0	0.03	4.10
5	E	7.12	150.0	6.0	0.03	4.50
6	F	6.95	140.0	3.0	0.03	4.80
MEAN		6.90	155.0	8.83	0.036	4.28
RANGE		6.71 - 7.12	140.0 - 180.0	3.0 - 18.0	0.03 - 0.05	3.70 - 4.80

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